

MASTER OF SCIENCE IN COMPUTER SCIENCE

SERVER PROBING FOR SERVER AND AGENT BASED ACTIVE NETWORK MANAGEMENT

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In Server and Agent Based Active Network Management (SAAM) architecture, a server will make routing and other important decisions on behalf of the routers in its region. In order to make the right decisions and to support QoS (e.g., IntServ and DiffServ), the SAAM server needs to maintain an accurate region-wide view of network performance. This will be achieved as routers periodically send Link State Advertisement (LSA) messages to the SAAM server. Currently, the LSA messages report two key Link Performance Statistics, the average delay and the loss rate experienced by packets. Moreover, the server needs to perform sanity checks of these statistics by probing specific links. This thesis describes a server probing solution in which the SAAM server probes a router by dynamically injecting customized probing programs into the adjacent routers. In other words, the probing will be done with the active networking approach. An important feature of the server probing solution is that the probing activities cannot be detected by the router being probed.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Active Networking, Quality of Service, Networks

DISTRIBUTED RELATIONAL DATABASE SYSTEM OF OCCASIONALLY CONNECTED DATABASES

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The Troop Command at the Presidio of Monterey requires an information system that will provide timely and accurate data about all serviced troop activities with students and permanent party stationed at the Defense Language Institute Foreign Language Center. Data sources that could provide required information already exist, but are physically spread over the Presidio, are maintained in diverse formats, and are not interconnected. Some data sources, maintained by other activities located at the Presidio, are available on the Campus Area Network. As new technologies emerged, it became possible to integrate all available data sources into a heterogeneous distributed information system, in which some information will be shared, while other information will be under some degree of local control. This thesis studies the feasibility of such an information system, and proposes one possible implementation.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Distributed Database, Heterogeneous Database System, PowerBuilder 7, SQL Server 7

DESIGN, IMPLEMENTATION, AND ANALYSIS OF THE PERSONNEL, OPERATIONS, EQUIPMENT, AND TRAINING (POET) DATABASE AND APPLICATION PROGRAM FOR THE TURKISH NAVY FRIGATES

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The Turkish Navy frigates have a challenging mission, which encompasses tactical, operational and administrative tasks. Lacking an automated information infrastructure hinders the ships' ability to efficiently perform the administrative activities, to generate the required reports quickly and to make effective decisions based on this information.

The objective of this thesis is to design and implement the Personnel, Operations, Equipment, and Training (POET) Database and Application Program for the Turkish Navy frigates and to analyze the potential benefits that will be obtained by using this system. The POET database system will provide the Turkish Navy frigates with an automated information system that will support the administrative activities, release manpower to perform other duties and reduce the productive power loss by increasing the availability, accuracy, and consistency of the data.

The thesis covers the analysis of requirements, conceptual database design using Semantic Data Model, logical database design on Microsoft Access DBMS, and implementation of the application program using Java and JDBC API. The result of this study is a functional application that will eliminate most of the current problems onboard the frigates and result in considerable savings of personnel power and time while providing the required information to the command quickly.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Manpower, Personnel, and Training

KEYWORDS: Database, Relational Database System, Semantic Data Model, Java, JDBC, System Maintenance, Design, Implementation and Analysis of Information Systems

COM AND XPCOM AS A SOLUTION TO BAMBOO'S VERSIONING PROBLEM

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Bamboo is a systems toolkit that is primarily concerned with supporting performance-critical applications that must run continuously for extremely long periods of time. Bamboo supports this by managing the loading and unloading of executable code into and out of process memory at runtime. Thus, as application requirements change over time, obsolete code can be replaced without having to restart the application. This technique's flexibility has already been demonstrated, but fails in one critical way. Although the C++ programming language standard defines a consistent syntax, it fails to specify a consistent binary encapsulation. Thus, if the executable code for a C++ base class is dynamically replaced, it is very likely that its in memory layout differs from before and therefore incompatible with whatever derived classes may exist. The only recourse is to recompile and reload the derived classes as well.

Component Object Model (COM) and Cross Platform Object Model (XPCOM) solve C++ weakness by enforcing a complete separation of a class's interface from its implementation. This thesis demonstrates support for dynamic versioning of Bamboo C++ modules using COM and XPCOM.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Modeling and Simulation

KEYWORDS: The Versioning Problem, Component Object Model, Cross Platform Object Model

DEVELOPMENT OF AN EXPERT SYSTEM AND INTELLIGENT SOFTWARE AGENT FOR AVIATION SAFETY ASSESSMENT

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The primary goal of this thesis is to design, develop and test an internet based prototype model for using expert system and software agent technologies to automate some of the analytical tasks in conducting aviation safety assessments using the data collected by the automated Aviation Command Safety Assessment (ACSA) system.

The Aviation Command Safety Assessment is a questionnaire survey methodology developed to evaluate a Naval Aviation Command's safety climate, culture, and safety program effectiveness. The survey was a manual process first administered in the fall of 1996. The survey was then automated in 1999 and is administered over the World Wide Web.

The results of this thesis are a prototype model and a software agent application that evaluates data contained in the ACSA database for organizational safety assessment and for database integrity. All source code is provided and discussed in detail.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Database, Java, Expert Systems, Software Agents, Aviation Safety

TESTING AND DEVELOPMENT OF A LOW COST, DIGITAL SIGNAL PROCESSOR BASED TORPEDO COUNTERMEASURE

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Since the early days of submarines, torpedoes have evolved from simple, straight running weapons into advanced vehicles capable of finding and evaluating potential targets. In contrast, torpedo countermeasures have changed relatively little and do not take advantage of inexpensive signal processing technology available today.

Digital Signal Processor (DSP) technology is used extensively in commercial applications making high performance DSP hardware available at relatively low cost. It is now possible to produce low-cost, DSP-based torpedo countermeasures capable of providing better performance than current fleet countermeasures at a fraction of current prices. By analyzing and responding to a threat torpedo's sonar signal only when the threat is actually present, DSP-based countermeasures provide customized decoy signals without having to flood the water with continuous transmissions.

Work on designing, building and testing such a device began at the Naval Postgraduate School (NPS) in 1997. This thesis describes the development, troubleshooting and testing of the NPS second-generation torpedo countermeasure prototypes. Methodologies are presented for hardware and software design efforts and an OpenGL 3D graphics computer simulation is provided. The hardware and software are described in detail along with the testing results and suggestions for future work in this important area.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Conventional Weapons

KEYWORDS: Torpedo Countermeasures, Digital Signal Processing, Acoustic Modem, Acoustic Telemetry, Acoustic Decoy, Signal Analysis

THE ROLE OF EXPERT SYSTEMS IN FEDERATED DATABASE SYSTEMS

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A shared information system is a series of computer systems interconnected by some kind of communication network. There are data repositories residing on each computer. These data repositories must somehow be integrated. The purpose for using distributed and multi-database systems is to allow users to view collections of data repositories as if they were a single entity. Multidatabase systems, better known as *heterogeneous multidatabase systems*, are characterized by dissimilar data models, concurrency and optimization strategies and access methods. Unlike homogenous systems, the data models that compose the global database can be based on different types of data models. It is not necessary that all participant databases use the same data model. Federated distributed database systems are a special case of multidatabase systems. They are completely autonomous and do not rely on the global data dictionary to process distributed queries. Processing distributed query requests in federated databases is very difficult since there are multiple independent databases with their own rules for query optimization, deadlock detection, and concurrency. Expert systems can play a role in this type of environment by supplying a knowledge base that contains rules for data object conversion, rules for resolving naming conflicts, and rules for exchanging data.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Modeling and Simulation

KEYWORDS: Multidatabase Systems, Federated Databases, Expert Systems, Semantic Networks

IMPLEMENTATION AND INTEGRATION OF THE OBJECT TRANSACTION SERVICE OF CORBA TO A JAVA APPLICATION DATABASE PROGRAM

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In examining the recent trend of the Client / Server computing technology, it can be seen that distributed object technology is ready to take off. The CORBA (Common Object Request Broker) architecture is the most widely known and readily available candidate for development.

The OMG (Object Management Group), a consortium of object vendors, developed the CORBA standard in the fall of 1990 as a common interconnection bus for distributed objects. Transaction processing is useful not only in database applications but also in building robust mission-critical applications. Utilizing CORBA one can build reliable distributed software systems in a much easier way. CORBA is the most widely accepted standard in this field and there are many CORBA implementations available now. Moreover, the transaction concept is the key to ensure the reliability and availability of Client/ Server applications.

In this thesis transaction properties were applied to a database application program based on Naval Postgraduate School's Course Iteration System. For this purpose an Object Transaction Service was provided based upon the CORBA architecture. It takes advantage of object-oriented programming to help programmers implement transactional applications in a much easier way.

In late 1994, the OMG also published the specification for the object transaction service. This specification is adopted as the blue print for this study. This thesis presents the implementation and integration of the object transaction service based on CORBA.

JDBC (Java Database Connection) was not used for transaction property, because JDBC is currently limited in that it cannot manage transactions across multiple connections. For transaction support across databases or object services, CORBA's Transaction Service provides the best level of abstraction.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Other (Database, Distributed Object Technology)

KEYWORDS: Software, Database, Distributed Object, Corba, OTS (Object Transaction Service), JDBC (Java Database Connectivity), Java

DEVELOPMENT OF A SOFTWARE EVOLUTION PROCESS FOR MILITARY SYSTEMS COMPOSED OF INTEGRATED COMMERCIAL-OFF-THE-SHELF (COTS) COMPONENTS

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Department of Defense (DoD) acquisition policy requires that military system acquisitions incorporate commercial-off-the-shelf (COTS) components into system architectures. Traditional DoD source code development and evolution methodologies do not effectively support COTS-intensive systems. To fully realize the benefits of COTS technologies and products, the DoD must adopt new ways to sustain system evolution in the face of a dynamic market environment subject to constant change.

The thesis proposes a new software evolution methodology to effectively maintain COTS-intensive military systems. The integrated COTS component evolution (ICCE) model provides evolution processes designed to support the maintainer as a consumer of software instead of a source-code developer. The ICCE model affords proactive risk awareness, market awareness, and user awareness activities. The ICCE model also supports a three-tier test and evaluation process. A case study for the U.S. Navy/Marine Corps Meteorological Mobile Facility Replacement (METMF (R)) program demonstrates the effectiveness of the ICCE risk management process.

DoD KEY TECHNOLOGY AREAS: Command, Control, and Communications, Computing and Software

KEYWORDS: COTS, GOTS, Software Evolution, Software Management, Risk Management, Software Evolution Model

FAULT TOLERANT APPROACH FOR DEPLOYMENT OF SERVER AGENT-BASED ACTIVE NETWORK MANAGEMENT (SAAM) SERVER IN WINDOWS NT ENVIRONMENT TO PROVIDE UNINTERRUPTED SERVICES TO ROUTERS IN CASE OF SERVER FAILURE (S)

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The current data networks are mainly based on sophisticated stand-alone routers that provide best effort service. However, with the explosive growth of the Internet and high demand on real-time network applications, the need for integrated service networks has emerged. For this purpose the Next Generation Internet (NGI) Project and as a part of this project the Server Agent based Active network Management (SAAM) project was initiated. SAAM is a server based hierarchical routing architecture designed to provide Quality of Service (QoS) routing services for network resource intensive applications. In the SAAM architecture, a small number of dedicated SAAM servers perform most of the network management

tasks on behalf of the routers. The SAAM server has a great responsibility in the SAAM architecture and failure of the SAAM server can have a devastating effect on the performance of the entire network. In order to tolerate the failure of the SAAM server and provide uninterrupted services to routers, this thesis examines the fault tolerance for the SAAM server in two phases: local area fault tolerance, and remote area (disaster recovery) fault tolerance. For the local area fault tolerance, after a survey of the literature and commercial offerings, a recommended solution is proposed. For the remote area fault tolerance, a backup server model is designed and prototyped. The prototyped model provides robust error detection and a fast recovery from the failure of the primary SAAM server.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Command, Control, and Communications

KEYWORDS: Fault Tolerance, Heartbeat Protocol, Next Generation Internet, Networks

AUTOMATED GENERATION OF WRAPPERS FOR INTEROPERABILITY

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Interoperability between software systems is the ability to exchange services from one system to another. In order to exchange services, data and commands are relayed from the service providers to the requesters. Presently, there are some interoperability techniques that aid the exchange of information, ranging from low-level sockets and messaging techniques to more sophisticated middleware technology like object resource brokers. Middleware technology uses higher abstraction than messaging, and can simplify the construction of interoperable applications. It provides a bridge between the service provider and requester by providing standardized mechanisms that handle communication, data exchange and type marshalling. However, the current interoperability techniques, data and services are tightly coupled to a particular server. Furthermore, most developers are trained in developing stand-alone applications rather than distributed applications. This thesis aims at developing a generic interface wrapper that can be used to separate the data and services from the server, and allows the developers to treat distributed data and services as those they are local within an application process space. In addition, the research developed a program to fully automate the process of generating the interface wrapper directly from a specification language such as Prototype System Description Language (PSDL).

DoD KEY TECHNOLOGY AREAS: Command, Control, and Communications, Computing and Software

KEYWORDS: Interoperability with JavaSpace, Jini, Loosely-Coupled Distributed Systems, Prototype System Description Language, Computer Aided Prototype System

DESIGN AND IMPLEMENTATION OF A THREE-TIERED WEB-BASED INVENTORY ORDERING AND TRACKING SYSTEM PROTOTYPE USING CORBA AND JAVA

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Many enterprises are still running and maintaining several operating system and platform dependent legacy applications. The variety of platforms and operating systems poses a challenge to system-wide interoperability and performance, increases the cost of maintenance, locks enterprises into certain vendors, and leads to a lack of an adequate information infrastructure which results in a waste of computer

resources, manpower, and time. In this thesis, a component-based three-tiered Web-based Inventory Ordering and Tracking System (IOTS) prototype has been designed and implemented that demonstrates the technical feasibility of making an enterprise's applications both interoperable and scalable on a system composed of multiple platforms and different operating systems. The prototype uses CORBA, an industry-backed, non-proprietary, standard-based distributed architecture and Java, a high-level object-oriented language that enables enterprises to leverage the use of the Internet and benefit from the enhancements in the client/server and the decrease in the prices of desktop computers. The prototype demonstrates how to overcome the problem of the stateless nature of HTTP and build the Object Web where Java applets run on the IIOP. The prototype's source code can be tailored to some specific business requirements and enterprises having problems similar to those addressed may benefit from this research and adopt its development methodology.

DoD KEY TECHNOLOGY AREA: Other (Interoperability, Re-Engineering, Inventory Ordering and Tracking)

KEYWORDS: Interoperability, Re-Engineering, Inventory Ordering and Tracking, CORBA, Java, Database, Electronic Commerce, Internet, Web-Database Connectivity

QOS MANAGEMENT WITH ADAPTIVE ROUTING FOR NEXT GENERATION INTERNET

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Up until today, the Internet only provides best-effort service, where traffic is processed as quickly as possible, with no guarantee as to timeliness or actual delivery. As the Internet developed into a commercial infrastructure, demands for quality of service (QoS) has become apparent. Several QoS service models have been developed to provide and support QoS in the Internet, namely: Integrated Service (IntServ), Differentiated Service (DiffServ) and MultiProtocol Label Switching (MPLS). QoS routing, such as Widest-Shortest Path, Shortest-Widest Path and Shortest-Distance Path, is required in order to support QoS and optimize the resource utilization.

The Server and Agent based Active network Management (SAAM) system is a network management system designed for the next generation Internet. It is capable of supporting all types of service class. It will be able to control and optimize the utilization of the network through resource allocation and adaptive QoS routing.

This thesis describes a design and implementation of the QoS Management component of a SAAM Server. This component optimizes the network resources and supports the various service classes in a cohesive manner, utilizing adaptive routing to balance the network load.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Other (Command, Communications, Control, Computers, and Intelligence)

KEYWORDS: Next Generation Internet, Integrated Service, Differentiated Service, MPLS, Quality of Service, Flows, Networks, Routing

REFINING A TASK-EXECUTION TIME PREDICTION MODEL FOR USE IN MSHN

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Nowadays, it is common to see the use of a network of machines to distribute the workload and to share information between machines. In these distributed systems, the scheduling of resources to applications may be accomplished by a Resource Management System (RMS).

In order to come up with a good schedule for a set of applications to be distributed among a set of machines, the scheduler within an RMS uses a model to predict the execution time of the applications. A model from a previous thesis was analyzed and refined to estimate the time that the last task will be completed when scheduling several tasks among several machines. The goal of this thesis was to refine the model in such a way that it correctly predicted the execution times of the schedules while doing so in an efficient manner.

The validation of the model demonstrated that it could accurately predict the relative execution time of a communication-intensive, asynchronous application, and of certain compute-intensive, asynchronous applications. However, the level of detail required for this model to predict these execution times is too high, and therefore, inefficient.

DoD KEY TECHNOLOGY AREAS: Computer and Software, Modeling and Simulation

KEYWORDS: Resource Management System, Operating Systems, Distributed Systems, Scheduling

TOWARD AN OBJECT-ORIENTED ARCHITECTURE FOR THE ENHANCED MULTI-SEGMENT TRACKER (EMST)

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This work is part of an ongoing effort to integrate the separate BEARTRAP post-mission analysis tools into an application operating in a Microsoft Windows environment. The new integrated system will replace the array of diverse processing systems currently being used for BEARTRAP post mission analysis. This thesis is the initial effort toward reengineering the Enhanced Multi-Segment Tracker (EMST) module to incorporate object-oriented capabilities and architecture. The module is an algorithm implemented in the C++ programming language for reconstructing a submarine's track through the water based on analysis of collected magnetic and acoustic data.

The first step requires reverse engineering the existing source code in order to understand the module. The hypothesis is that by reverse engineering the EMST source code, the attributes, behaviors and relationships that characterize the system can be identified, which will enable the future construction of objects for reengineering the system into an object-oriented architecture. The thesis describes the reverse engineering tasks performed on the existing EMST source code and presents methods for determining the attributes, behaviors and relationships that characterize the algorithm.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Software Engineering, Software Reverse Engineering, Software Re-Engineering, Object-Oriented Technology, Unified Modeling Language, BEARTRAP

RE-TARGETING THE GRAZE PERFORMANCE DEBUGGING TOOL FOR JAVA THREADS AND ANALYZING THE RE-TARGETING TO AUTOMATICALLY PARALLELIZED (FORTRAN) CODE

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This research focuses on the design of a language-independent concept, Glimpse, for performance debugging of multi-threaded programs. This research extends previous work on Graze, a tool designed and implemented for performance debugging of C++ programs. Not only is Glimpse easily portable among different programming languages, (i) it is useful in many different paradigms ranging from few long-lived threads to many short-lived threads; and (ii) it generalizes the concept of intervals over Graze's original definition. Glimpse's portability has been validated by demonstrating its usefulness in performance debugging of both Java programs as well as automatically parallelized FORTRAN programs.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Performance Debugging, Java Threads, Automatically Parallelized FORTRAN Applications

COMMUNICATION MODELS IN MOBILE COMPUTING SYSTEMS AND MOBILE AGENTS

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This thesis study covers wired and wireless mobile computing environments, introduces the components of the mobile environment, discusses the constraints of mobility, and contains a taxonomy of the current techniques/models that reduce the overheads associated with wireless mobile communication. One of the goals of this thesis study was to identify and define communication techniques and models that are used by mobile computing systems to minimize wireless communication cost. The following communication techniques and models have been covered in this study: caching, screen caching, differencing, protocol reduction, header reduction, data access profile, delayed writes, strict and loose reads, semantic callbacks and validators, data allocation, data compression, data scheduling, proxy process, adaptation strategy, resource revocation, auto connect/disconnect, and adaptive antennas. The trade-offs between these techniques/models have also been presented. Other goals of this study were to introduce scripts and mobile agents, and explore their security features in mobile computing environments. The usage of mobile agents in military applications has been investigated. Finally, conclusions and recommendations have been provided for wireless mobile computing and mobile agent technology.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Mobile Computing, Portable Computers, Mobile Environments, Mobile Agents, Intelligent Agents, Wireless Networks, Caching, Proxy Process, Adaptation, Mobile Communication, Wireless Communication, Disconnected Operation, Energy Consumption, Cellular Communication

**AN ANALYSES OF INTERNET/INTRANET INFORMATION SYSTEM ARCHITECTURES
WITH ORACLE 8i FOR TURKISH NAVY**

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Turkish Navy has made a strategic commitment to Oracle DBMS, by making an enterprise contract with Oracle Corporation, which places Oracle DBMS at the heart of all information processing in Turkish Navy. Ten years later currently established Oracle DBMS based information systems will be legacy systems and Turkish Navy will be bound to under Oracle proprietary lock-in, unless careful approach in deploying these new systems is not made.

Oracle 8i is the latest version of the Oracle Corporation's DBMS can be solution to this problem. With Oracle 8i's Java-enabling components-Object Request Broker (ORB), Java Virtual Machine (JVM), and embedded JDBC Driver- Turkish Navy have a wealth of technologies at its disposal. Turkish Navy has a choice of several programming models - PL/SQL, JDBC, SQLJ, CORBA, and EJB; and a choice of protocols - Net8 and CORBA-IIOP. Selecting model over another can be a daunting and very important task. Each model has strengths and weaknesses for a particular task.

This research surveys Oracle Java Platform and researches different development architectures with their pros and cons, and points out the direction that should be taken in order to ensure scalability, maintainability, interoperability and extensibility of the future systems which will prevent the proprietary lock-in of the certain vendors and their products.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Other (Information System Management)

KEYWORDS: Oracle, Oracle 8i, Enterprise Java Beans, CORBA, Information System Architectures, Microsoft vs. Oracle, Turkish Navy, EJB, Java, PL/SQL

**A MODEL FOR GENERATION AND PROCESSING OF LINK STATE INFORMATION IN
SAAM ARCHITECTURE**

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This thesis presents a model of link state advertisement generation for the SAAM (Server and Agent Based Network Management) architecture. The model includes generation and processing of link state data. In a SAAM network, a central server manages a region of 20-40 lightweight routers. The server learns the link performance of the routers from processing Link State Advertisement messages that are periodically sent by the routers. The server uses the information to maintain a Path Information Base to manage routing within the region. A router also sends a triggered Link State Advertisement message when one of its interfaces fails.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Quality of Service, Networks, Flows, Link State Advertisement